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GERMAN U-BOAT STRENGTH 1942

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German U-Boat Strength, 1942

1. On the basis of construction activity throughout the war period in German and German-controlled shipyards, it is estimated that Germany's total strength in ocean-going submarines, 500 tons or more, had increased from 60 at the beginning of the war to 261 by the beginning of May, 1942. This assumes an average monthly loss rate of three, from beginning of the war until the end of 1941, and a rate of four losses per month, thereafter. The figure 261 compares closely with an estimated total strength of 258, derived independently from operational intelligence.

2. A survey on submarine slips, conducted in April, 1942 by aerial reconnaisance, affords a basis for estimating prospective accretions to German submarine strength during the last 8 months of 1942.

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German Shipyards

1942	Submarines Launched	Ready for Service
January	22	
February	24	
March	36	
April	29	
May	25	22
June	24	18
July	~~21~~ 16	33
August	29	36
September-	~~20~~ 18	23
October	~~24~~ 33	18
November	23	~~25~~ 20
December	28	~~29~~ 27
	~~315~~ 07	~~202~~ 197

The following intervals for building and fitting-out are believed to apply in the German yards, in 1942: (in months)

500 tons		750 tons		1,000 tons	
Bldg.	Fitting out	Bldg.	Fitting out	Bldg.	Fitting out
7	2	8	3	12	4

A further two month interval is allowed for trial runs, between completion and entry into service.

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The estimated average rate of launchings per month of about 26 (deviations ranging from -10 to +10) for the whole of 1942 compares with an estimated rate of 18 (deviations ranging from -5 to +11) in 1941 and of 5 (deviations ranging from -5 to +7) in 1940. For the years 1940 and 1941 building periods for 500 ton and 750 ton U-boats were estimated to have been one month longer, and for 1,000 ton U-boats two months longer. The increase in launchings in 1942 over the former years is due chiefly to an expansion of the number of U-boats building at any one time from about 23 at the beginning of the war to about 180 by August, 1941, when the number of ways levelled off.

3. In addition to the accretion of ~~202~~ 197 submarines, from May through December, 1942, it is believed that one submarine will be completed at Stettin, and perhaps as many as 33 in Dutch and French yards. This would indicate an addition of fully ~~23~~ 1 submarines to the German fleet in the eight months, May-December, 1942.

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4. If the estimated loss rate of 4 per month were maintained, the German submarine fleet would thus consist of 465 submarines at the close of 1942 (261 plus 236 minus 32).

5. On the whole this figure may be taken as an outside estimate. It is capable of being reduced by bombing operations, sabotage, shortage of trained crews, or the imposition of a higher loss rate on the German U-Boat Fleet.

6. Chart I, page 4a, presents graphically estimates by months of the number of U-boats launched and completed in German yards and ready for service in 1942.

Knowledge of the probable <u>increase</u> per period in total strength may help to determine the intensity of the total German submarine campaign at given points of time. For example, for the next two months, Germany would be able to increase the number of U-boats operating in a particular area without reducing them anywhere else, or without shortening their periods in port. 1/ In the early fall months of this year,

1/ A cable report from Bern states that many recruits have just finished their training and that U-boat warfare is soon to be stepped up. Bern, May 30, 1942, #2377.

4a

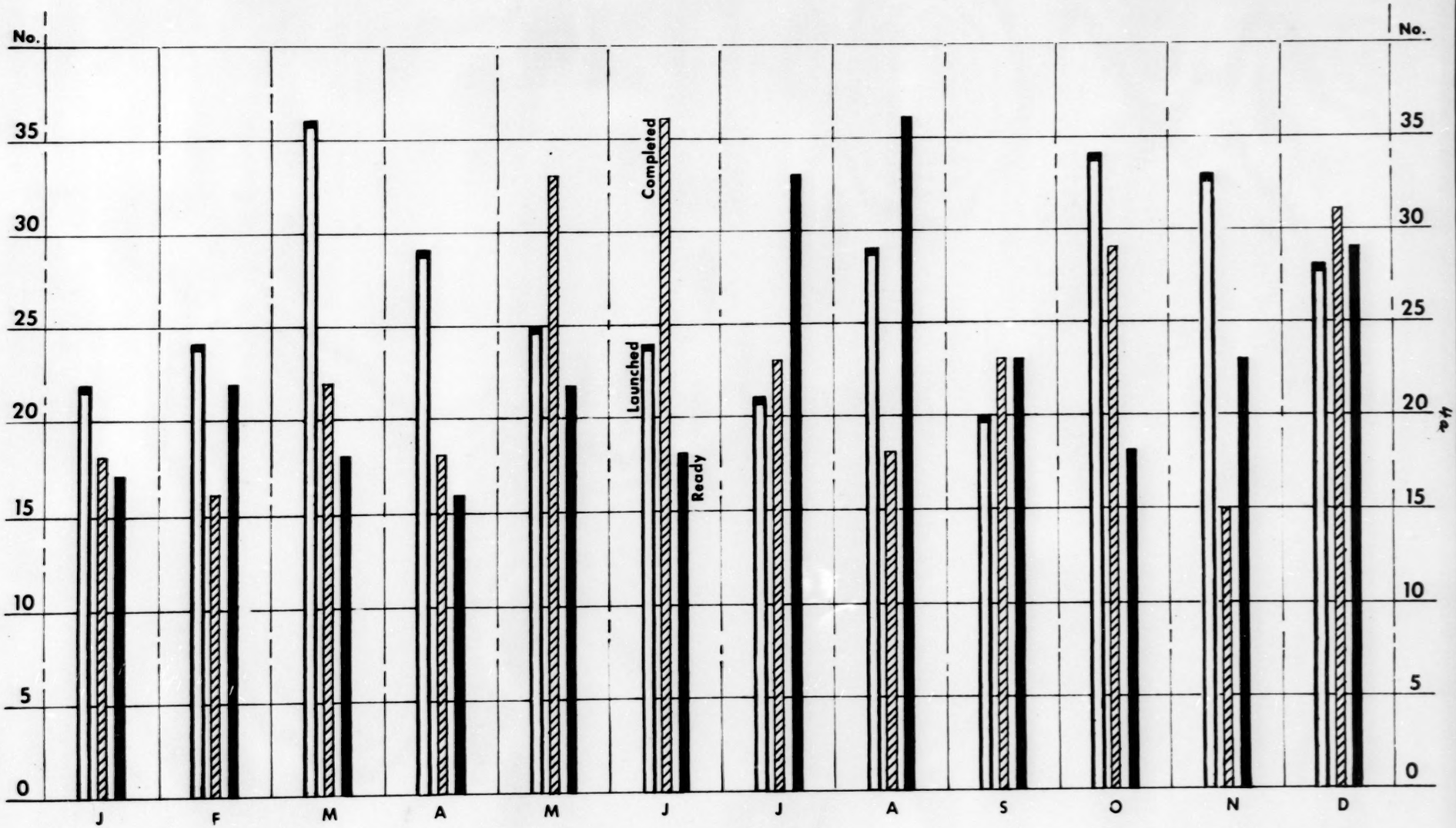

chart 1

OCEAN-GOING U-BOATS COMPLETED IN GERMAN YARDS AND READY FOR USE IN 1942 PER MONTH (Estimated)

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on the other hand, an equal increase of activity in one area would be possible only at the expense of some reduction in activity somewhere else.

7. Operational intelligence available at this time (report of April, 1942) indicates that no less than three times the number of U-boats on patrol are in bases, training school, on trials or working up. In February, 1942 the ratio of U-boats on patrol to total strength was even smaller. Assuming the same distribution of U-boats between different areas, the number of U-boats on patrol in the Atlantic will increase from 48 (as of April 21, 1942) to between 70 and 80 by September, 1942, and to between 85 and 95 by the end of the year.

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II. THE APPROACH

Most of the estimates submitted in the summary are based upon reconstructions of building activity by months in the individual German yards for the period 1940-42. The chief sources of information from which the basic pattern of construction activities was derived were:

(a) British intelligence prior to overall aerial reconnaissance[1]

(b) British aerial reconnaissance from April to September, 1941

(c) British aerial reconnaissance in April, 1942[2]

The method employed, which in principle has been the same for the fourteen out of fifteen or sixteen German naval yards (including Danzig) on the North Sea and Baltic Coasts, may be indicated briefly by following the reconstructed activity in the Kriegsmarinewerft and Deutche Werke in Kiel, and the Kriegsmarinewerft in Wilhelmshaven.

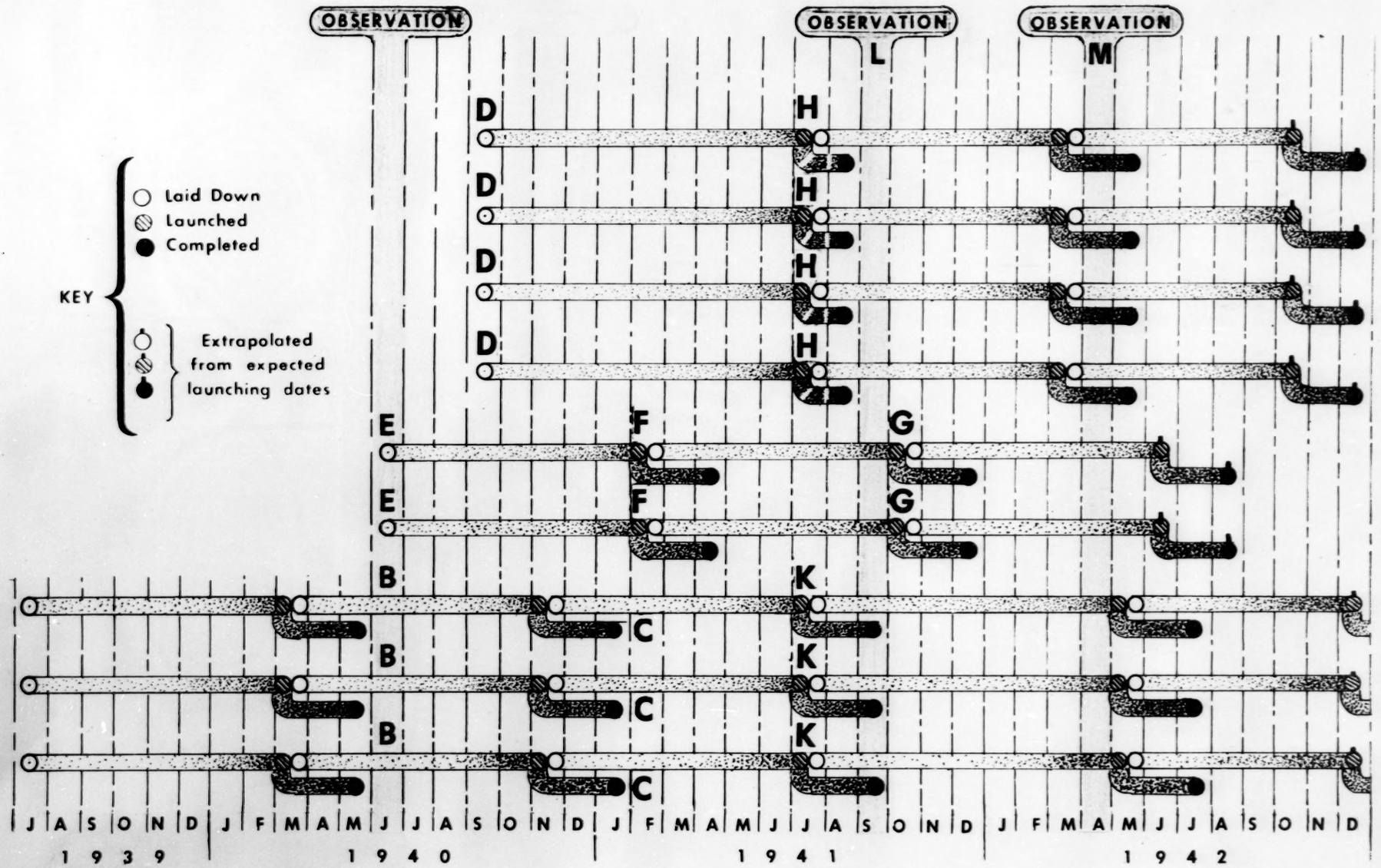
1. Construction Activity

(a) Reconstruction of production schedules in individual German yards

The diagrams on pages 6a, 8a, and 10a show the reconstructions. The following information was available:

1/ M.E.W. 2/1/214/Z, 15. III. 41; cited hereafter as Z.

2/ Both N/A reports on file in O.N.I.



RECONSTSRUCTION OF U-BOAT PRODUCTION IN THE KRIEGSMARINEWERFT AT KIEL

6a

Supplementary Information Based on N.I.D. report of June 18, 1942

Immediately after compilation of the final draft of the present memorandum, the results of a more recent aerial reconnaissance (up to June 1) became available. This necessitated the following changes:

(1) Submarines launched and ready for service in 1942:

Launched	Ready for Service
July 1942: reduced from 21 to 16	November 1942: reduced from 23 to 20
September 1942: reduced from 20 to 18	December 1942: reduced from 29 to 27
October 1942: reduced from 34 to 33	

Chart II, page 12a, should be changed to conform with the new figures for launchings. No change is required in the estimate of the average monthly rate of launchings of about 26 for the whole of 1942.

(2) There is evidence that between April and June of this year, a new expansion of the number of U-boats building at any time has taken place; the earlier expansion had levelled off in August 1941. For all German yards the figure is about 28. It includes 2 observed to be building in Rostock.

(3) There is evidence that Germany probably has in service 3 submarines of the 1600 ton class. As of June 1942, four of this type were building and one was fitting out in German yards.

(4) In the Wilhelmhaven diagram, page 10a, no new keels should be laid at P.

5 Bremen

13 x 1000 bldg.
4 x 1000 fitting
7 x 750 bldg
5 x 750 fitting

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(i) Estimates of some keel laying and launching dates in 1939-41 for the Kriegsmarinewerft in Kiel.

(ii) Aerial reconnaissance for the Kriegsmarinewerften in Kiel and Wilhelmshaven and the Deutche Werke in Kiel separately from April to September, 1941.

(iii) Aerial reconnaissance for all Kiel yards together, but specifying by tonnages, and separately for the Kriegsmarinewerft in Wilhelmshaven.

(i) An early M.E.W. report[1] estimates 3 completions of 500 ton submarines in October - November, 1940, in the Kriegsmarinewerft in Kiel. This, on the general assumption of a 2 or 2 1/2 month's fitting-out period would imply corresponding launchings in August-November of 1940. However, the same report points out that the estimates of completions were based on optimum conditions which in all probability did not obtain. For this reason, and because of later aerial observation which supports this assumption, the three launchings mentioned above, have been placed in November, 1940, (C).

(ii) The first aerial photograph of the yard in June, 1940, showed 4 U-boats of the 500 ton class building (B) and none fitting out. The presumption

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[1] M.E.W., Z.

[2] N/A Oct. 1, 1941. on file in O.N.I.

is that there were the 3 estimated subsequently to have launched in November, 1940, plus an additional 1 laid down sometime previously(E). The report containing the results of aerial reconnaissance 2 also states that at the beginning of September, 1941, 21 had been laid down, including the 4 original ones, that 5 were laid down between June and September, 1940, that 12 had been launched and 9 of these completed by September, 1941. Furthermore, the report states that at the beginning of September, 1941, 9 were seen building and 3 fitting out. The completion dates for these 12 are estimated as follows:

1941	September.....	3
	December	2
1942	April - May	4
	June - July	3

In the diagram on page the 5 keels reported to have been laid between June and September, 1940, have been expanded to 6, i.e., 4 in September (D) and 2 in June (E), one 1 of which was observed by the aerial reconnaissance in June, 1940. This expansion was necessary in view of subsequent information on the yard. As mentioned above, out of the total of 21 laid down up to September, 1941, 9 are reported to have completed by August, 1941, i.e. 3 (C) plus 2 (F), launched

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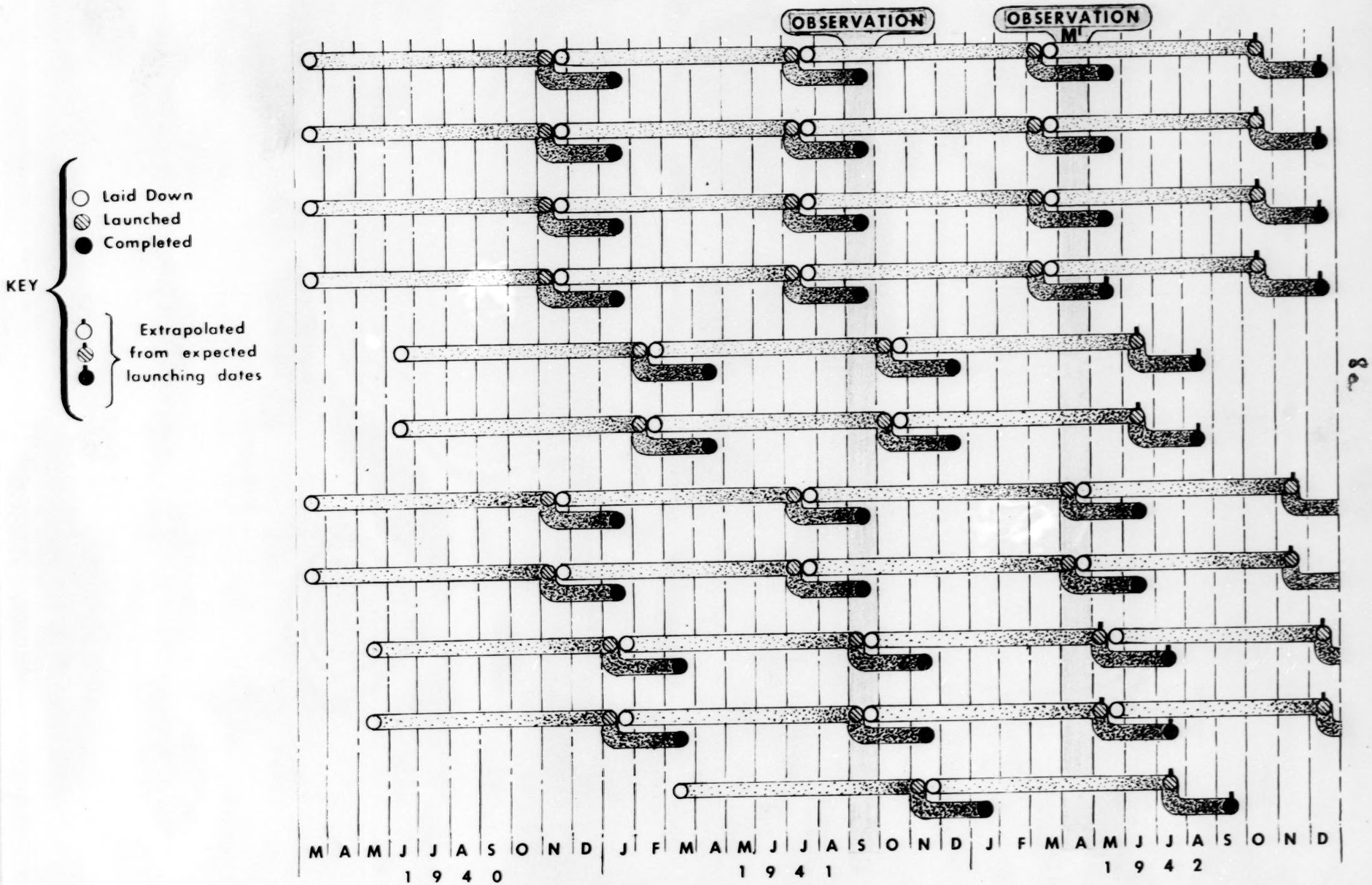
OBSERVATION
OBSERVATION
M'
KEY
Laid Down
Launched
Completed
Extrapolated from expected launching dates
M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1940
1941
1942

RECONSTRUCTION OF U-BOAT PRODUCTION IN THE DEUTSCHE WERKE AT KIEL

at the latest in February, 1941, so as to vacate ways for 2 more to be completed in December, implying their launchings in October (g) plus 4 keels laid in September (d) and launched probably at the beginning of July (H). This calculation implies a delay of (D) in building of about one month and a fitting-out time of about two months.1/

Similar considerations, were applied to the available data on the Deutche Werke in Kiel.

Aerial reconnaissance in September, 1941 (I) showed 9 building and 3 fitting-out at the Kriegsmarinewerft in Kiel, i.e. 3 laid in July, 1941 (K) plus 2 laid in February, 1941 (F) plus 4 laid in July, 1941 (H); and 3 fitting-out, i.e. the 3 launched in July, 1941 (K). The 4 launched in July, 1941 (H) must have finished their fitting-out period by that time and were, therefore, not observed. Since 4 more were expected to be launched in March, 1942, the way at (H) must have been vacated. Later aerial observation does not show any addition to the total number of U-boats building.

(iii) A check on the extrapolations from the last launching dates given in the preceding paragraph was provided by a second report on aerial reconnaissance in April, 1942,2/ covering the coast line from Bordeaux to Trondheim in the North

1/ See below p. 15 for estimates of building and fitting-out times.

2/ N/A report May 21, 1942, on file at O.N.I.

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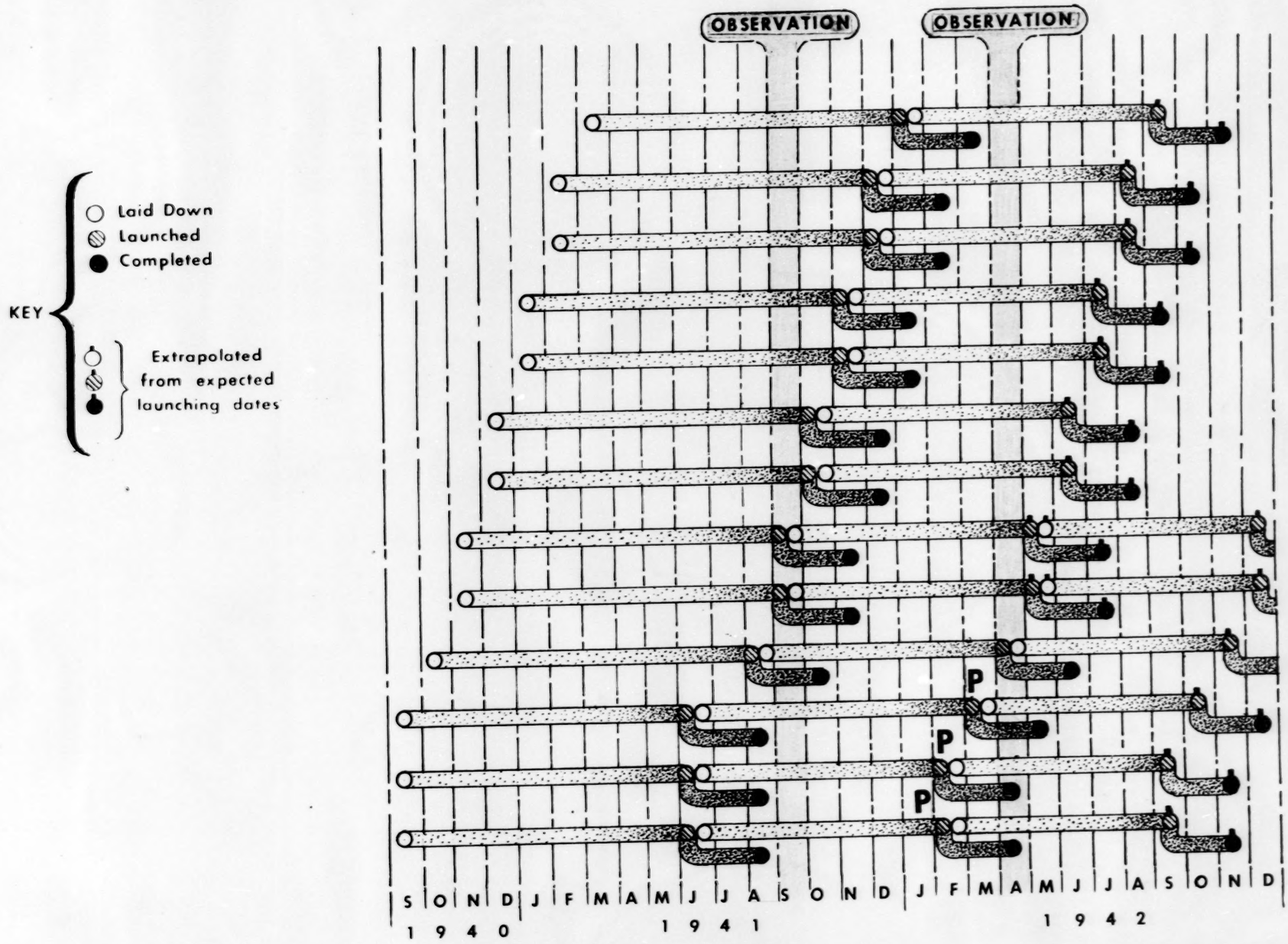

RECONSTRUCTION OF U-BOAT PRODUCTION IN THE KRIEGSMARINEWERFT AT WILHELMSHAVEN

Reconstruction of activity in the Kriegsmarinewerft at Wilhelmshaven illustrates the effects on launching and keel laying dates of known characteristics of particular yards. Aerial reconnaissance from June, 1940, to September, 1941, for example, suggests that a large number of U-boats spent eleven months or more on the slips. This is taken into account in the reconstructed building program as shown on p. 10a. Aerial reconnaissance in April, 1942, showed ten building. According to the reconstructed plan on page 10a, 13 ought to have been building. However, since the yard showed delays before, possibly due to the bombing of workshops adjacent to the yard, launchings at (P) may have taken place somewhat later and the 3 vacated ways may not immediately have received new keels again. There are no figures for U-boats fitting out at that time, although the reconstructed production schedule would call for 2 or 3 in that stage of construction. Only when new information becomes available will it be possible to determine whether or not the number of ways at Wilhelmshaven has actually been reduced since the last quarter of 1941. In this memorandum the number of ways is assumed to have remained unchanged.

In addition to the three yards, described for purposes of illustration, the information on 11 other yards has been pieced together.

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Yards for which sufficiently accurate information is available for reconstruction of production activity.

Name	Tonnage	Location
Blohm und Voss	500	Hamburg
Bremer Vulkan	500	Vegesack
Flensburger Werke	500	Flensburg
H. C. Stülcken & Sohn	500	Hamburg
Howaldtswerke	500	Hamburg
Kriegsmarinewerft	500	Kiel
Kriegsmarinewerft	500	Wilhelmshaven
Lübecker Flenderwerke	500	Lübeck
Nordseewerke	500	Emden
Deschimag	750	Bremerhaven
Deshimag	750	Bremen
Deutsche Werke		
Finkenwärder	750	Hamburg
Germania Werk	(750) (1000)	Kiel

The result of adding the estimates of monthly launchings at these yards for 1939 - 1942 are shown in Chart II. The output of the German yards at Danzig and Elbing has been included in the form of an average monthly distribution of launchings throughout 1941 and 1942. This merely raises the level of the curve without

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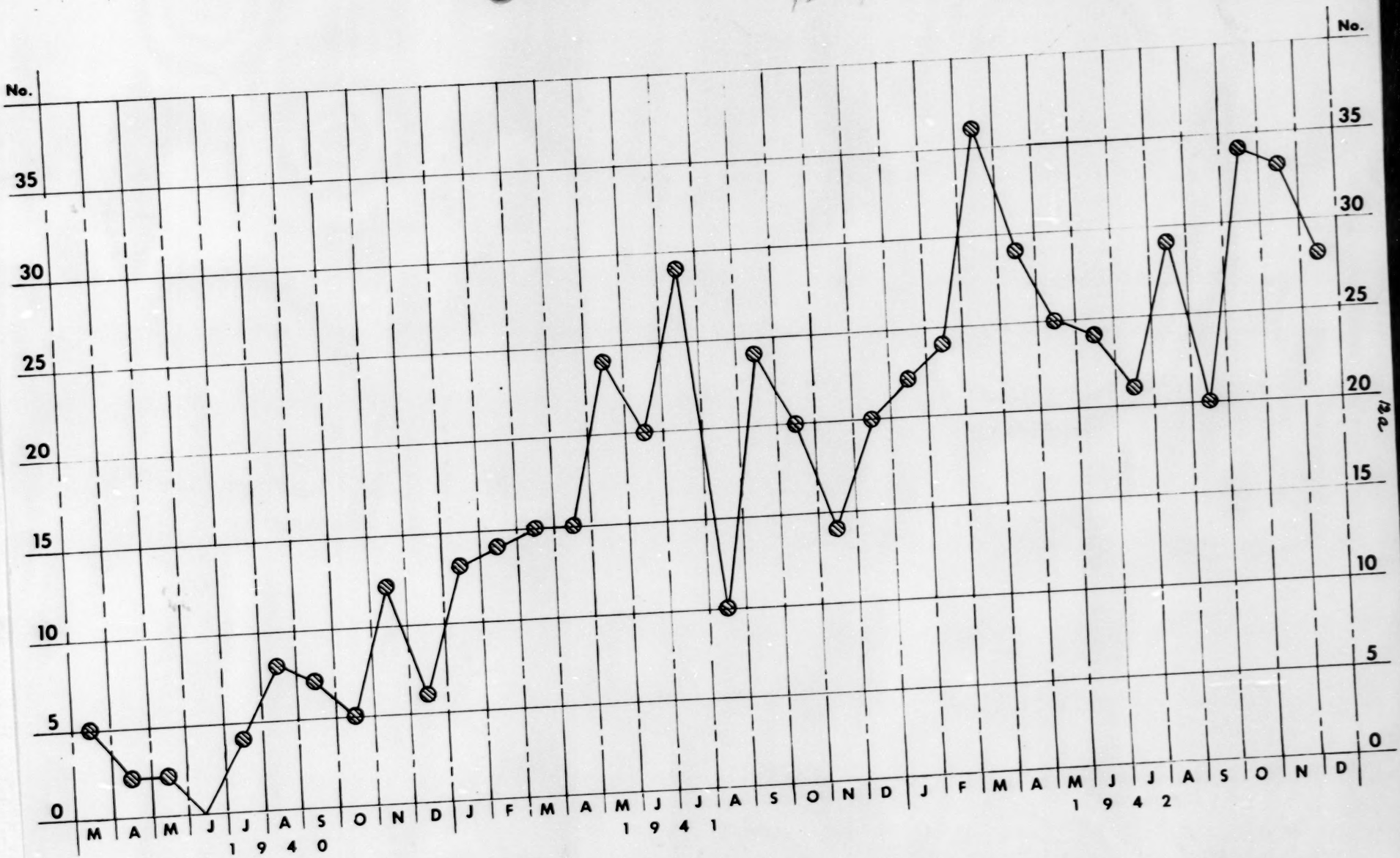

chart 2

OCEAN-GOING U-BOATS LAUNCHED IN GERMAN YARDS 1940-1942 PER MONTH (Estimated)

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influencing its shape. Launchings in the yards of the occupied zones of Holland and France are not included since so far the information has been too scanty to allow of detailed reconstruction of activity there. The probable output of the French and Dutch yards has been included, however, in the totals on page 23.

The fluctuations on the chart are due chiefly to two factors. First, the growth of total capacity up to the time when the total number of ways levelled off was highly uneven. Secondly, different building times have been assumed respectively for, (a) the 500 ton and the 750 ton classes, and (b) for 1939-41 and 1942. It so happens that the number of months elapsing before the time when the curve of increase in the total number of ways (estimated at 180) levelled off was an integral multiple of the building time of eight months. Thus, had the growth been even and the same building time allowed for all classes of U-boats throughout the whole period, launchings per month would have been constant from the 25th month onward. In other words, if we had started with a constant flow of output from a constant number of ways at the end of 1939, the flow of launchings would again have levelled off at the end of 1941, i.e., after 24 months, provided that growth had been linear throughout

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these twenty-four months and that the same building time had been allowed for all U-boats and throughout the whole period. It should be emphasized, however, that a levelling off of the total number of ways at sometime does not mean that the rate of launchings also will ultimately level off.[1] Even in the absence of an uneven growth in the total number of ways, and of varying building times for different classes of submarines and for different periods, the rate of launchings would still have fluctuated provided only that the number of months elapsing before the total number of ways levelled off was not equal to an integral multiple of the number of months assumed as building time.

---

[1] With an even growth in the total number of ways the cycle will always be equal in length to the building time. Let S be the time elapsing before the total number of ways (T) levels off, B the building time, D the gap in output when S<B, or the addition to the rate of launchings reached when the total number of ways level off, when S>B, all in terms of months; let R be the rate of output reached when T levels off.

Then for $S < B$

$D = S - B$

$R = \Delta T$

for $S > B$

$D = B - (n+1)B + S$ where $n = \left[\frac{S}{B}\right]$

$R = n \Delta T$

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(i) Unless there was evidence of delays in particular yards, building and fitting out times have been assumed as follows:

	500 tons		750 tons		1,000 tons	
	Bldg.	fitting out	Bldg.	fitting out	Bldg.	fitting out
1939-41	8	2	9	3	13	4
1942	7	2	8	3	12	4

For the earlier period the usual British estimates have been used. Although there is much evidence of the possibility of shorter building periods both in Germany during the last war and in the United States at the present time, the British estimates tally well with the results of repeated aerial reconnaissance. Furthermore, it is unlikely that American building times now reached after about one year of experience with mass production could be duplicated in 1939-41 in Germany under greater war strains. The effects of aerial bombardments, both of the yards themselves and of factories producing equipment,[1] as well as the necessity of carrying out the larger part of welding in the day time because of the black-out,

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[1] The M.E.W., Z report of March 15, 1941, gives a substantial list of the number of times per month particular yards constructing U-boats were attacked to that time. The attack on Augsburg in 1942 will have slowed down U-boat construction. Output of the Diesel factory there is expected to be 30% below normal for May to JUly and 10% to 15% until September. (Cable, Bern May 30,1942 #2377). However, only a proportion, although a substantial one, of the yards fit engines made in Augsburg. Blohm und Voss in Hamburg, for example, seems to obtain most of theirs from Duesseldorf;

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will have maintained the longer building period, i.e., 8 months instead of the 6 months possible in the United States. There is definite evidence of delays other than those caused by aerial bombardment[1] at various times in four large yards before October, 1941. Material and labor shortages are not likely to have slowed down U-boat production in 1940-1941. There is sufficient evidence to indicate that even in 1942 U-boat construction received first priority rating.[2]

(ii) For U-boats to be built completely in the course of 1942, a shorter time on the ways has been applied. There is sufficient evidence of building by the band method in the larger yards. U-boats are moved forward from one stage to the next on their trollies, each reaching the head of the line when nearly ready for launching.[3] Fitting out also, at least at Blohm und Voss in Hamburg proceeds on the principle of the conveyer belt. The U-boats pass in sequence along the fitting out berths, a method not used in this country according to reliable information.[4]

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1 N/A October 1, 1941 on file O.N.I.

2 W.A.R. No. 47 (17.I.42).

3 O.N.I., 18 III 42, British source, interrogation of P/W.

4 Bureau of Ships.

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Prefabrication of sections of the pressure hulls and also of bows also make a shorter building period more probable in 1942. There is evidence also, that the curve of the total number of ways had levelled off by August, 1941 so that at least some material and labor formerly used in the yards to construct equipment necessary for additions to the number of ways such as cranes and gantries may now be available for work on U-boat construction. There is no evidence of serious material shortages and some evidence of increased use of resources in occupied or Allied countries, for prefabrication of submarine parts.[2] On the basis of this information, then, the time for building and fitting out used in the reconstruction of individual yards was reduced from 10 to 9 months for the 500 ton class, and from 11 to 10 months for the 750 ton class.

(iii) Unless specific information was available it was assumed that new keels always replaced launchings within the same month. British sources usually include in their estimates a full month for repairing ways after launchings. Experience in the United States shows that such repairs are not always necessary.

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[1] W.I.R. No. 108, April 3, 1942

[2] N/A report, February 26, 1942, on file O.N.I.

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2. The Derivation of Estimates of Total Strength

(a) Estimate for May, 1942

In the last quarter of 1938 Germany had available 13 U-boats of the ocean-going classes of 500, 517, and 712 tons. At that time there were building or projected 23 of 740 and 517 tons.[1] Assuming that most of these were finished early in 1939, another batch of 23 could have come off late in 1939. This indeed would tally with the British andAmerican estimates of 58 to 60 at the beginning of the war.

To these were added all the estimated launchings from the 14 yards for which fairly accurate information is available for the years 1939, 1940 and 1941. Launchings of 500 tonners from January to April 1942 inclusive, of 700 tonners from December to April inclusive, and of 1,000 tonners from November to April inclusive should not properly be included in the estimate of total U-boat strength available for service on May 1st. At that time only the launchings through December, November and October, 1941 respectively would have completed their trials. From the 14 German yards, there should have been available 240 U-boats by May 1, 1942.

1/ Karl Dönitz, Nauticus 1939, p. 195.

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To these have to be added ~~9~~ 1,000 ton U-boats launched at the Blohm und Voss and Germania yards by the end of 1941, ~~12~~ 500 ton U-boats said to have been launched before August, 1940 at the Germania yard, and ~~2~~ 740 ton U-boat completed in 1940 at Koenigsberg.[1]

Information of construction activity in the yards at Danzig and Elbing is scanty but a picture, reasonable in view of later aerial reconnaissance, may be pieced together as follows.

At the end of August, 1941 MEW estimated that 15 to 23 submarines of 500 tons were building and 7 to 10 fitting out.[2] Taking the larger figures this meant that at least 10 submarines were completed in 1941. Of the 23 building, 13 could have been on the ways up to 8 months and 10 up to 2 months (assuming 8 months building time and 2 months fitting out). For lack of specific information an average building time was taken. It was assumed that 13 of the submarines had been on the ways 4 months and 10, 1 month. This put their keel laying dates at the beginning of May and July respectively. The 13 submarines laid in May were considered to have been launched by the end of

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1 M.E.W. Z.

2 W.A.R. No. 31, week ending September 20, 1941

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To these have to be added ~~9~~ five 1,000 ton U-boats launched at the Blohm und Voss and Germania yards by the end of 1941, ~~12~~ twelve 500 ton U-boats said to have been launched before August, 1940 at the Germania yard, and ~~1~~ one 740 ton U-boat completed in 1940 at Koenigsberg.[1]

Information of construction activity in the yards at Danzig and Elbing is scanty but a picture, reasonable in view of later aerial reconnaissance, may be pieced together as follows.

At the end of August, 1941 MEW estimated that 15 to 23 submarines of 500 tons were building and 7 to 10 fitting out.[2] Taking the larger figures this meant that at least 10 submarines were completed in 1941. Of the 23 building, 13 could have been on the ways up to 8 months and 10 up to 2 months (assuming 8 months building time and 2 months fitting out). For lack of specific information an average building time was taken. It was assumed that 13 of the submarines had been on the ways 4 months and 10, 1 month. This put their keel laying dates at the beginning of May and July respectively. The 13 submarines laid in May were considered to have been launched by the end of

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1 M.E.W. Z.

2 W.A.R. No. 31, week ending September 20, 1941

of 1941 and completed by the end of February, 1942. Thus from Danzig and Elbing 23 U-boats were estimated to have finished their trials by the beginning of May, 1942.

Whereas new keels laid in the occupied zones of Holland and France were kept separate from the figure for total strength, those building when these areas were occupied were assumed to have been completed and to have finished trials so as to have been available for service by the beginning of May, 1942. Their total number was 19.[1]

So far then, total German U-boats strength, on May 1, 1942 without deducting sinkings, was made up as follows:

on next page.

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[1] MEW, Z

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(1) At beginning of the war..... 60

launched

(2) 14 German yards (see p.12 for list)

	500	750	Total	
1939		3	3	
1940	33	18	51	
1941	146	40	191	
Total	179	61	240	240

(3) 1,000 ton Boehm und Voss and Germania yards 6

(4) 500 tons, Germania Werft before Aug., 1940 12

(5) 750 tons, Koenigsberg, completed in 1940 1

(6) Danzig and Elbing 500 tons: 1941 - 10
1942 - 13 23

(7) Acquisitions from occupied French and Dutch yards up to May, 1942 19

Total 361

Only two rough estimates on the rate of sinkings of U-boats are available. The first states sinking to have been 3 a month from September, 1939 to November, 1940.[1] This rate has been used in this report up to the end of 1941. According to the second estimate, referring to the present period, 4 are sunk per month. This rate has been used for all calculations in 1942.[2] The total of 361, therefore, has to be reduced.

(8) Sinking at the rate of 3 per month to the end of 1941 and 4 thereafter.[1] 100

Total strength at end of April, 1942 261

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[1] British Source; ONI, June 2, 1941

[2] British Source; verbally communicated by Mr. Bennet, ONI.

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(b) Estimate of Total Strength to the End of 1942

The estimate of total strength to the end of 1942 was obtained by adding U-boats of 500 tons launched from January to August, 1942 inclusive, those of 750 tons from December, 1941 to July, 1942, inclusive, and those of 1,000 tons from November, 1941 to June, 1942 inclusive, in the 14 German yards for which fairly accurate information is available. The total from this source should come to 172 ready for service at the end of 1942.

At the end of August, 1941, 23 submarines were estimated to have been building and 10 fitting in the Danzig and Elbing yards. Of the 23 building, 13 were launched at the end of 1941 and included in the total estimate of strength for May 1st. It was assumed that the remaining 10 had been building since the beginning of July, 1941 and were launched by the end ofFebruary, 1942. They should become ready for service by July, 1942. The 13, whose keels were laid to replace boats launched by the end of 1941 should launch in August, 1942, (assuming a 7 months building period) and, therefore, become ready for service by December, 1942.

Aerial reconnaissance on March 3, 1942 indicated 25-30 submarines building in the Danzig and Elbing yards, an increase of 7 over the estimate of August 30. These additional 7 could have been on the

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ways as long as 6 months. Taking the average time they had been building as 3 months, they were considered to have launched at the end of May, 1942 and ready for service by the end of September. To sum up, therefore, an estimated total of 30 submarines of 500 tons should become ready for service in the Danzig and Elbing yards from May through December, 1942. There was also 1 x 500 ton U-boat building at the Oderwerke in Stettin in April, 1942.1/

Total German U-boat strength at the end of 1942 excluding the output of the occupied French and Dutch yards, for the last 8 months of the year and without deductions for sinkings should be as follows:

(1)	At the beginning of May, 1942				261
		launchings			
(2)	14 German yards	500	750	1,000	67
		126	42	4	~~172~~
(3)	Danzig and Elbing				30
(4)	Stettiner Oderwerke				1
			Total		~~44~~ 59
(5)	Less sinkings at the rate of 4 per month				32
	Total strength as of end of 1942				~~432~~ 27
(6)	Potential output of Dutch and French yards on basis of observation of 33 building in March, 1942				33
	Total including French & Dutch				~~460~~

1/ J/W papers (June, 1942)

HKH/HB June 24, 1942